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TECHNICAL REPORT

CLIMATE VULNERABILITIES AND DEVELOPMENT IN BURKINA FASO AND NIGER

BACKGROUND PAPER

November 2012
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CONTENTS

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ACRONYMS

AAP	Africa Adaptation Program
ACCCA	Advancing Capacity to Support Climate Change Adaptation
AGRHYMET	Centre Regional de Formation et d'Application en Agrométéorologie et Hydrologie Opérationnelle
ALP	Adaption Learning Program
AMESD	African Monitoring of the Environment for Sustainable Development
AREN	Association for the Revitalization of Livestock Breeding in Niger
CBA	Community-Based Adaptation
CC DARE	Climate Change Adaptation and Development Initiative
CNPC	China National Petroleum Corporation
CONASUR	National Council for Emergency Relief and Rehabilitation
CONEDD	National Council for the Environment and Sustainable Development
CSR/PGCA	Committees for the Prevention and Management of Food Crises
CTNCVC	National Technical Commission on Climate Change and Variability
DGPER	Direction of Production and Rural Economy
DNPGCA	National Machinery of Food Crisis Prevention and Management
DPCIE	Division du Partenariat et de la Coordination des Conventions Internationales en matière d'Environnement
EWS/ER	Early Warning System
FAO	Food and Agriculture Organization
FEWS NET	Famine Early Warning Systems Network
FMNR	Farmer-Managed Natural Forest Regeneration
GEF	Global Environment Fund
GTZ	German Agency for Technical Cooperation
IBRD	International Bank of Reconstruction and Development
IFAD	International Fund for Agricultural Development
IFC	International Finance Corporation
IPCC	Intergovernmental Panel on Climate Change
JICA	Japan International Cooperation Agency

NAFSIP/RDS	National Agricultural Investment Plan
NAPA	National Adaptation Program of Action
NPRS	National Program for the Rural Sector
OSV	Vulnerability Monitoring Observatory
PDIPC	Climate Information Development and Forecasting Project
PICOFA	Community Investment Program for Agricultural Fertility
PPCR	Pilot Program for Climate Resilience
PROMOVARE	Water Resources Mobilization and Development Project
SAM	Severe Acute Malnutrition
SAP	Early Warning System
SCAP/RU	Community-based Early Warning and Emergency Response System
SRDP	Sustainable Rural Development Program
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
UNITAR	United Nations Institute for Training and Research
VIGIRISC	Vigilance et Gestion Intégrée du Rique Climatique
WB	World Bank
WMO	World Meteorological Organization

1. EXECUTIVE SUMMARY[1]

1.1 REGIONAL ISSUES

Burkina Faso and Niger are among the poorest countries in the world, with per capita Gross Domestic Products (GDP) in 2011of $1,300 and $800, respectively. More than 80% of the citizens of each country live in rural areas. Agriculture is the most important sector to both Burkina Faso and Niger, contributing 34% and 40% to their GDPs, respectively. Agriculture employs a large majority of both countries' labor force.

Climate variability already has significant impacts on the region, which are likely to evolve given global climate change. In the 1970s and 1980s, there were over 100,000 drought-related deaths in rural communities due to the long-term decline in rainfall and drought in West Africa's Sahel region. Between 1980 and 2010, droughts have affected the most people in the region, epidemics have led to the most deaths, and floods have caused the largest economic damages. Furthermore, the region is experiencing an overall trend toward greater climate variability, with more frequent droughts, heat waves, and floods.

Climate is projected to continue to change. Temperature is expected to increase in the 21st century as part of global climate change. However, there is no consensus among current climate models on how rainfall will change over the long term. Climate changes will likely have a myriad of impacts on Burkina Faso and Niger.

Population pressure and other factors have contributed to food and water scarcity, as well as the loss of natural resources, ecosystems, and animal and plant species. Soils in the region are largely degraded from overuse. Climate change is exacerbating this.

There are two primary climate-sensitive health issues affecting Burkina Faso and Niger: under-nutrition and infectious disease. Climate change will likely cause shifts in the timing, seasonality, and geographic range of disease epidemics, particularly malaria and meningitis (e.g., pushing the meningitis belt southward). Limited access to water supply and sanitation systems and frequent floods and droughts aggravate health conditions and disrupt the livelihoods of rural and urban populations. In addition, in the future, there will likely be health issues for "climate migrants" displaced by flood or drought.

Rural women and children are particularly sensitive to climate variability and change. For example, during periods of drought, women have to go further to access drinking water, affecting their ability to engage in productive labor.

Despite some progress, generation of climate information is not sufficiently coordinated or harmonized between the major climate institutions in West Africa; technical services and other end-users are often unaware of climate information; and the information that is being produced often does not sufficiently consider end-user needs, thus constraining its potential uptake and use. Institutional strengthening and capacity building within the two governments and their civil societies is needed to improve the development, use, and interpretation of the latest information.

[1] References for specific facts and figures in the Executive Summary can be found throughout the body of the report.

The national governments of Burkina Faso and Niger should continue to strengthen and implement their long-term climate policies, based upon input from a broad range of constituencies. The national policies should be infused throughout the countries' legal and regulatory frameworks across all sectors.

The policies should ensure that national-level management effectively empowers regional and local decision making and initiative to address the uniqueness of the challenges and to capitalize on the insights and traditional capabilities that exist at those scales. The national governments should actively coordinate the complex set of development partners and help to ensure that the appropriate sets of resources are utilized. The approaches should be designed to be robust in the face of potentially intermittent funding from within the country and from donors.

Given the rural, subsistence nature of the populations in Burkina Faso and Niger and their high levels of vulnerability, the most important adaptation entry points should be farmers and extension agencies, (most likely through the work of rural-focused non-governmental organizations (NGOs)). A wide range of adaptations are outlined in the final section of the report. They are focused on agriculture, food security, natural resource management, water systems, urban populations, health, infrastructure, and disaster risk reduction.

1.2 BURKINA FASO OVERVIEW

Burkina Faso faces economic shocks, persistent underemployment, poor infrastructure, high deficits, ineffective and corrupt government, political- and security-related instability, severe rural poverty, rapid population growth, malnutrition and health related concerns, poor water and sanitation, and gender inequality. Burkina Faso has very little economic diversity with GDP dominated by exports of gold and cotton. Burkina Faso has some of the most underdeveloped infrastructure in West Africa. In 2010, only 50% of urban households and 6% of rural households had access to improved sanitation.

Most rivers in Burkina Faso are ephemeral, with the exception of the Mouhoun River (Black Volta) and the Nakambe River (White Volta). Flow in the major rivers has decreased due to dam construction, a change in rainfall regime, and extensive land use changes. The combination of standing water and poor sanitation leads to disease outbreaks and especially high rates of malaria. The major limitations to providing safe water and sanitation are the availability of water and funding, as well as the technological and engineering difficulties of extracting groundwater in Burkina Faso. When water supplies dry up, populations, especially in the Central Plateau, migrate to the east and west in search of better living conditions. Forecasts of flood risk, onset of the rainy season, and locust risk are provided by different agencies. However, the accuracy, timeliness, and usefulness of these forecasts for decision making are often deficient.

Burkina Faso has articulated its adaptation priorities in three national-level documents: its initial national communication to the United Nations Framework Convention on Climate Change (UNFCCC), its national strategy, and its National Adaptation Programme of Action (NAPA). Across these three documents, Burkina Faso prioritizes actions supporting agriculture, water resources, and forestry. However, partly due to the rotation of staff and changing institutional arrangements, action on climate change has been isolated and sector-specific. Despite a large number of reports on climate change in Burkina Faso, few of the recommendations have been implemented. The National Council for the Environment and Sustainable Development (CONEDD) within the Ministry of the Environment and Quality of Life is the only government entity identified as having capacity on climate change, with the issue often confused elsewhere

with general environmental management. So far, no links have been made between disaster risk reduction and climate adaptation by CONEDD and the National Council for Emergency Relief and Rehabilitation.

1.3 NIGER OVERVIEW

High population growth is placing a heavy burden on Niger's basic social and economic infrastructure, and is increasing demand on scarce land, energy, and water resources. In 2010, only 34% of urban households and 4% of rural households had access to improved sanitation. However, Niger's economic prospects for 2012 and the medium-term are good since GDP is expected to increase 11% in 2012 and level off to around 6% annual growth rate in in 2013, primarily due to mining and oil.

Despite its dry climate, Niger has water resource potential from the Niger and Komadougou rivers, Lake Chad, streams, and groundwater. Desertification has contributed to the shrinking of lakes and ponds, most prominently Lake Chad which shrunk 94% from the 1960s to the 2000s. Ninety percent of the renewable surface water resources of Niger is generated outside of its borders, most prominently via the Niger River, which has declined from an average of 32 billion m^3 per year (the 1930-1960 average) to 23 billion m^3 in the late 20th century. Flooding in Niger has resulted in loss of life, damage to infrastructure, and river siltation.

Institutional gaps can be addressed by close collaboration between development partners and the Government of Niger. For example, the National Technical Commission on Climate Change and Variability (CTNCVC) is made up of 29 members from state institutions, private organizations, and civil society, and deals with priority issues such as agriculture, livestock, energy, water, and infrastructure. However, since its creation in 1997, the CTNCVC has only been able to organize two general meetings, though its operational Executive Secretariat has met more frequently.

Niger's adaptation priorities are described in their Second National Communication on Climate Change and National Adaptation Programme of Action. Several plans are in place to address agriculture and food security. For example, Niger developed a National Agricultural Investment Plan in 2010 designed to increase resiliency in the agricultural sector. Niger has been using a relatively sophisticated early warning system and has increased training related to nutrition since the 2010 drought crisis. Niger is implementing some pilot adaptation projects and developing approaches to address climate-related food crises through the African Adaptation Programme, which are scheduled to end in late 2012. Niger and the World Bank's (WB) Pilot Program for Climate Resilience (PPCR) also reached an agreement in mid-2012 on four climate change programs costing nearly $100m—a mix of loan and grant funding.

2. DEVELOPMENT CONTEXT

2.1 BURKINA FASO

2.1.1 ECONOMIC

Burkina Faso's economy grew 5.2% annually on average between 2000 and 2010, with a total GDP of $10.2 billion in 2011 (World Bank, 2012a). Its GDP per capita was $1,300[2] in 2011, ranking 205 out of 226 countries (CIA, 2012). Agriculture and industry represent 34% and 26.5% of the country's economic output, respectively (State Dept., 2012). Gold mining has been the country's fastest growing industry, increasing by 11.8% of GDP between 2006 and 2011, largely due to government measures to increase foreign direct investment and the rising market value of gold (AEO, 2012). Burkina Faso is Africa's largest exporter of cotton, employing 17% of the population and accounting for 60-70% of export earnings (State Dept., 2012). Furthermore, while formal sector unemployment remains low at 1.8% of the population living in urban areas, the country suffers from severe underemployment amongst the country's large rural population (AEO, 2012). Economic growth remains a priority as the government seeks to expand the mining industry, improve market access for Burkinabé goods, invest in critical infrastructure, and increase secondary/university education.

2.1.2 SOCIAL

Burkina Faso has a population of 17.2 million, which is growing at a rate of 3.1% percent or an average of 6.2 children per woman of reproductive age (CIA, 2012). Population growth of this magnitude has created an overwhelmingly young population with 59.1% of the population under the age of 20 (IMF, 2012). Eighty percent of the population relies on subsistence agriculture, which contributes to the persistence of the country's severe poverty and poor education (State Dept., 2012). The population is an ethnically integrated split between two major West African groups, the Voltaic and the Mande. The population is 60.5% Muslim, 19% Christian, and 21% other religions (CIA, 2012).

Despite consistent growth, Burkina Faso remains one of the poorest countries in the world, ranking 181 out of 187 on the 2011 United Nations Development Programme (UNDP) Human Development Index. In 2011, rising government discontent and deep social malaise led to country-wide protests resulting in vandalism, destruction, and mutiny. The protests ended shortly thereafter and the country is undergoing major political reforms with some success. The major priorities for human development are increasing access to proper healthcare and sanitation, reforming the education system to reduce dropouts and increase participation by women, and introducing contraceptives to rural populations to reduce the country's high growth rate.

While the vast majority of Burkina Faso's population remains rural, urbanization rates have risen as people migrate from drought-plagued regions in search of job opportunities and food security in cities. The droughts affecting the country since the 1970s and 1980s have led the poor and vulnerable populations to migrate into the valleys and the small basins of the rivers, which in turn aggravates the aftermath of flooding events, particularly in the outskirts of cities that are in the flood plain. Currently, 20% of Burkinabés are urban dwellers, with the percentage on the rise since 2005.

[2] GDP per capita measured on a purchasing power parity basis for both Burkina Faso and Niger.

2.1.3 ECOLOGICAL

Burkina Faso is characterized by shrub steppes, arboreal and shrub covered savannah, and open woodland forest as a result of the arid climate in the north and a relatively cooler and wetter climate in the south. The distribution of land across the entire national territory is as follows: cultivated land (13%), arable land (40%), protected areas (classified forest, reserves, national parks, 16%), and grazing land during the rainy season (61%) (World Bank, 2010). The percent of agricultural lands is growing, at the detriment of grazing lands. The soils are poor in nutrients, have little capacity for storing water, and are largely degraded from overuse (GFDRR, 2011). The government recognizes that a majority of the population depends on the land and has made environmental protection part of the county's constitution, with legislative frameworks on water management and rural tenure (AEO, 2012). A priority for sustainable ecological management is to increase the conditions for and sustainability of agriculture.

2.2 NIGER

2.2.1 ECONOMIC

Niger's GDP is $6.5 billion (AFDB, 2012), with agriculture contributing 40% of GDP, services 45%, and industry approximately 16% (World Bank, 2012b). Niger's GDP per capita was $800 in 2011, ranking 222 out of 226 countries (CIA, 2012). Ninety percent of the country's labor force is engaged in agricultural activity, with 6% in industry and 4% in services (Republic of Niger, 2009). Subsistence farming and animal husbandry, including pastoral and agro-pastoral farming, are the main sources of income for rural dwellers (CIF, 2012). The recent crises in Côte d'Ivoire, Nigeria, and Libya have caused some 300,000 migrants to return to Niger, worsening unemployment among young people, and deleteriously affecting economic growth (AEO, 2012). From 2010 to 2011, there was a 4-8% reduction in economic growth. However, since Niger has one of the world's largest uranium deposits and significant oil reserves, stronger economic growth is expected from 2012-2016 (CIA, 2012). Priorities for economic growth include; continuing to expand mining and oil production, promoting youth employment, and maintaining agricultural production.

2.2.2 SOCIAL

Niger has a population of about 16.4 million (CIA, 2012), 90% of which live in one-third of the country's area (AEO, 2012) and 83% of which live in rural areas. Niger's population growth is one of the highest in the world at 3.3% and its urbanization rate is 4.7% (CIA, 2012). As one of the world's poorest countries, Niger faces extreme poverty and hunger and ranks 186 out of 187 countries on the 2011 UNDP Human Development Index score. In 2011, only about half of the population had access to clean water and only 9% had proper sanitation (JMP, 2012). While health conditions and services in Niger have significantly improved under the government's 2011-2015 health development plan, more than 50% of the country's population is estimated to be chronically food insecure and 44% of children under five are chronically malnourished (WB, 2009; AEO, 2012). Net primary school enrollment is rising. However, the education system is still relatively poor and greater efforts are needed to address gender and geographical disparities. The priorities for human development in Niger are addressing extreme poverty and hunger, ensuring food security and nutrition, curbing population growth, improving access to potable water and sanitation, and improving reproductive healthcare (AEO, 2012).

2.2.3 ECOLOGICAL

Niger is characterized by desert plains, steppes, and savannas. Savannas are especially important to the country as they have economically valuable shea, baobabs, and other natural resources. Niger's forestland spans across 14,000,000 hectares and provides the country with 87% of its domestic energy needs. Forests also serve as a source for fodder, traditional medicine, and scientific research. Soils in Niger tend to be poor in nutrients and organic matter content, have a low fertility level and water retention capacity, face increasing acidification, are subject to salinization, and are exposed to water and wind erosion (SNC, 2009).

Niger is home to 3,200 animal species (CIA, 2012). Despite its dry climate, Niger has great water resource potential from the Niger and Komadougou rivers, Lake Chad, streams, and groundwater; however, only 1% of surface water and 20% of ground water are exploited. Artificial water reservoirs also make it possible to store large quantities of water (SNC, 2009). Priorities for sustainable ecological management and conservation are improving access to water and other natural resources, managing ecosystems such as wetlands, and protecting wildlife and habitat.

2.3 NON-CLIMATE STRESSES

2.3.1 BURKINA FASO

Burkina Faso faces non-climate stresses including rapid population growth, low economic development, poor governance, gender inequality, and a lack of security. The population of Burkina Faso is expected to double over the next 20 years—nearly half of its population is currently under the age of 14. Rapid growth in population adds strain to already depleted natural resources and hampers efforts to meet the Millennium Development Goals. For example, the capacity to provide education to all Burkinabé youth is already underdeveloped and it will be difficult to meet the secondary and vocational education needs of the already sizeable and growing youth population.

Burkina Faso has very little economic diversity and infrastructure to support economic growth. GDP is dominated by exports of gold and cotton, leaving the economy highly vulnerable to market price fluctuations. Burkina Faso is also vulnerable to changes in market prices for grains, which directly affect food security. Over a 6 month period in 2008, the price of rice, the main staple food for urban populations, rose from $28 for a 50 kg sack in January to $46 by early June. Furthermore, underemployment among rural populations has eliminated any opportunity to pursue growth in other sectors such as Information and Communications Technology (ICT) and sustainable tourism. Poor roads, energy grids, ICT, and basic sanitary infrastructure have held back economic competitiveness and contributed to poverty. Moreover, most existing and planned infrastructure projects are limited and focused on cities, while rural areas remain completely underdeveloped (AEO, 2012). Gender inequity has hampered productive economic contributions of women.

Corruption and inefficiency within the government has deterred much needed foreign investment, obstructed efforts to improve health and education, and withheld basic legal services to the people. Although comprehensive government reforms are taking place following the 2011 political unrest, the country remains extremely unstable.

2.3.2 NIGER

Niger's non-climate stresses include rapid population growth, low economic development, gender inequality, and regional instability. High population growth is placing a heavy burden on Niger's basic social and economic infrastructure, and increasing demand on scarce land, energy, and water resources (AEO, 2012). Population pressures have also contributed to loss of natural resources, ecosystems, and animal and plant species (AEO, 2012). Overexploitation of natural resources has affected agricultural land and production, and contributed to recurring food insecurity and poor nutrition (Canadian Red Cross, 2007). Niger's economy and food security are also highly vulnerable to price fluctuations in the world commodity market and the economies of neighboring countries. Niger's economic prospects for 2012 and the medium-term are good as GDP is expected to increase 11% in 2012 and level off to around 6% annual growth rate in 2013, primarily due to mining and oil (AEO, 2012). Nevertheless, Niger's poverty levels remain high. About 60% of the population lives in extreme poverty on less than $1 a day and 85% survive on $2 a day (AEO, 2012). Political crises in neighboring countries like Nigeria, Libya, and Côte D'Ivoire have contributed to a reduction in economic growth and led to the return of about 300,000 migrants. This situation coupled with Niger's high population growth has worsened unemployment, particularly among young people.

Niger faces a number of pressing environmental issues, including deforestation, desertification, soil erosion, pollution, bushfires, overgrazing, wildlife poaching, and habitat destruction (CIA, 2012). Desertification, due in part to an expanding Sahara desert, has contributed to the shrinking of lakes and ponds, most prominently Lake Chad which shrunk 94% from the 1960s to the 2000s. The shrinking of Lake Chad affected the water supply of communities in the area dependent on the lake for drinking, agricultural production, and their livelihoods. Niger's wetlands have also suffered significant loss due to over exploitation (NAPA, 2006). A lack of adequately developed and enforced national and trans-boundary water resource management laws negatively affects the quality, accessibility, and availability of water resources in Niger.

3. CLIMATE CHANGE IMPACTS AND VULNERABILITY

3.1 WEATHER AND CLIMATE IMPACTS OF CONCERN

3.1.1 REGIONAL OVERVIEW

From Northern Niger to Southern Burkina Faso, these countries span the Saharan, Sahelian, and Sudano climate regions. From North to South, temperature generally decreases while annual rainfall amount and rainy season duration increase. Rainfall is highly variable both within seasons and from year to year. Figure 1 shows the spatial distribution of year-to-year variations in surface wetness. The map shows above average moisture during August 2012 (end of the growing season) while the surrounding time series illustrate the spatial variability in soil moisture over the 20-year period of record. For example, the time series in the top right corner shows that northern Niger received almost no surface water throughout the period of record (harsh desert). Meanwhile, the figure in the bottom left corner shows appreciably more water resources over the last 20 years.

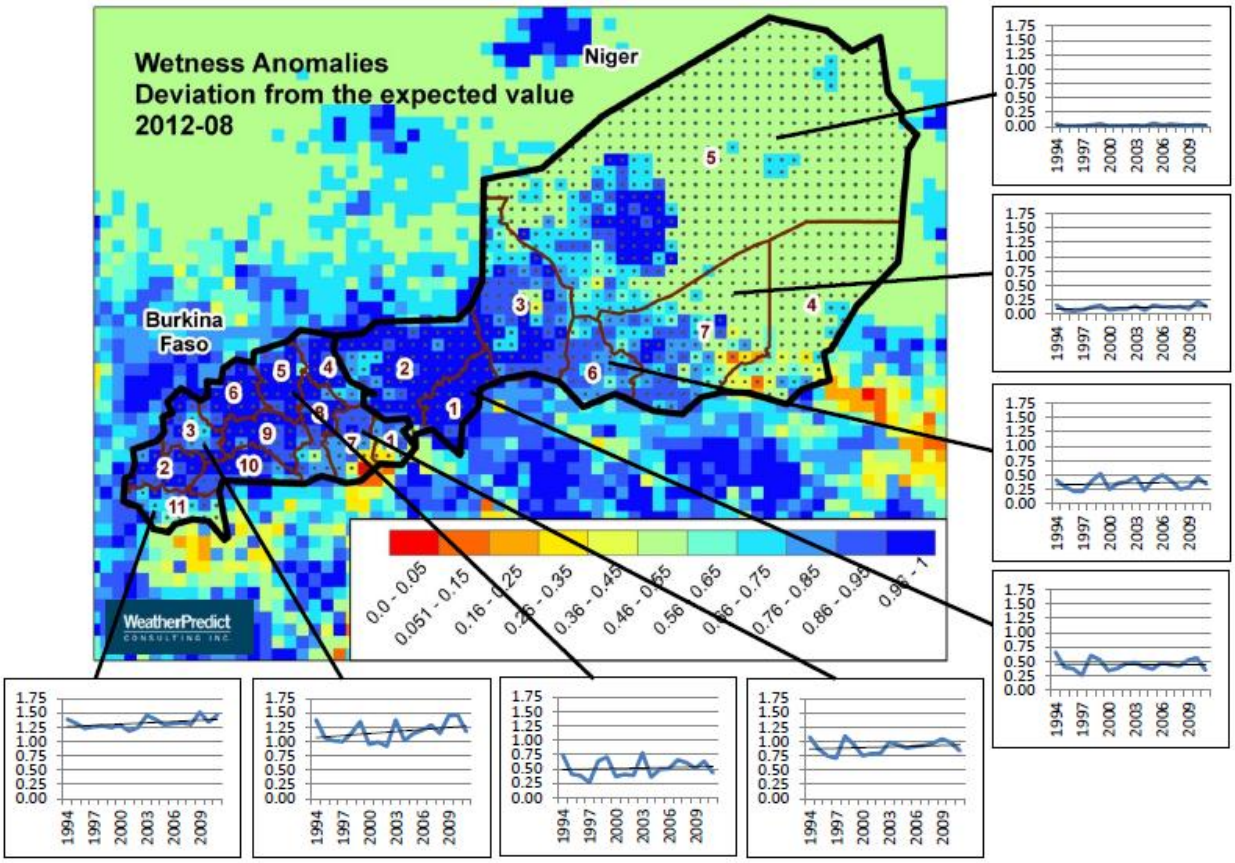

FIGURE 1: SURFACE WETNESS. The map shows a snapshot from August 2012 of surface wetness anomalies. Conditions in this month were significantly wetter than normal (Average wetness for a given location and time of the year is 0.5. Values below 0.5 represent drier-than-average conditions; values above 0.5 represent wetter-than-average conditions). The time series show the percentage of the surface that is water in each of the delineated regions. The time series show the extreme dryness that characterizes the northern tier of the region and the much moister conditions in the south. The time series also show the large regional and year-to-year differences in wetness. The data set is produced using information from the Special Sensor Microwave/Imager satellites (Basist et al., 1998).

High rainfall variability and frequent drought has had devastating effects in the region. From the 1970s to the 1980s, there were over 100,000 drought-related deaths in rural communities due to a long-term decline in rainfall and drought in West Africa's Sahel region (UNEP, 2006). Figures 2a and 2b show observed precipitation and temperature trends for Burkina Faso and Niger since 1900.

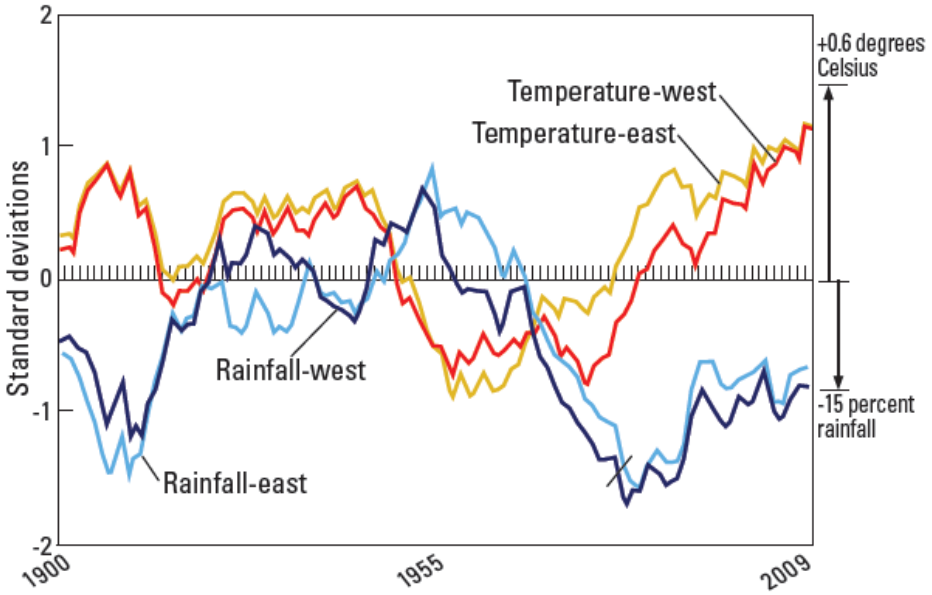

FIGURE 2A: BURKINA FASO RAINFALL AND AIR TEMPERATURE. Observed, smoothed rainfall and air temperature time series for east and west Burkina Faso. Mean rainfall and temperature are based on the 1920–1969 time period. The dark blue and light blue lines represent rainfall anomalies for the western and eastern parts of the country, respectively. The red and orange lines represent temperature anomalies for the western and eastern parts of the country, respectively. The data are for June-September from each year. Anomalies are computed relative to the 1920-1969 average (Source: FEWS NET, 2012a)

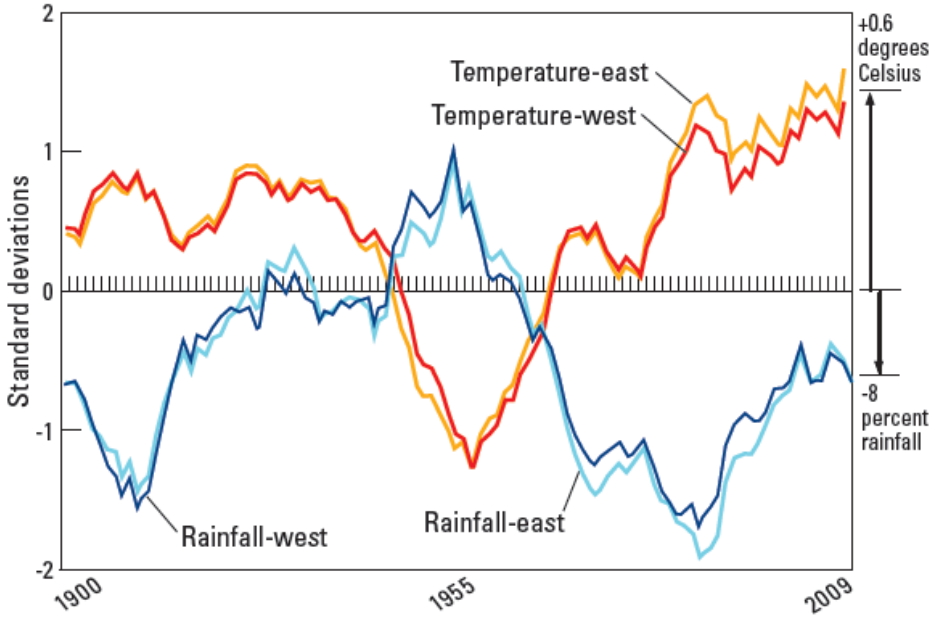

FIGURE 2A: NIGER RAINFALL AND AIR TEMPERATURE. Observed, smoothed rainfall and air temperature time series for east and west Niger. Mean rainfall and temperature are based on the 1920–1969 time period. The dark blue and light blue lines represent rainfall anomalies for the western and eastern parts of the country, respectively. The red and orange lines represent temperature anomalies for the western and eastern parts of the country, respectively. The data are for June-September from each year. Anomalies are computed relative to the 1920-1969 average (Source: FEWS NET, 2012b)

Observations clearly indicate a general increase in temperatures, a trend that is expected to continue as part of global climate change. However, there is no consensus among current climate models on how rainfall will change over the long term.

3.1.2 BURKINA FASO

Burkina Faso has a dry tropical climate with high average temperatures and dry conditions. Three climate zones split the country from north to south: the Sahelian zone in the north experiences rainfall of less than 600 millimeters per year (mm/year), the Sudano-Sahelian region on the Mossi Plateau experiences 600-900 mm/year of rainfall and slightly cooler temperatures, and the southern, more humid Sudanian zone has average rainfall between 900 and 1200 mm/year. Each of these zones experiences a pronounced wet and dry season, with the wet season extending over a two-month period in the north (beginning late June to early July) and a six-month period in the south (beginning late March to early April). The length of the growing season varies from less than 60 days in the north to 160 days in the south, with large inter-annual variations. The dry season is influenced by the harmattans, or dry, easterly winds that bring hot air to the region from March to May (World Bank, 2011).

Observed Trends. Observations since 1902 indicate that the country's dry region has expanded southwards over the 20th century (World Bank, 2011; UNFCCC, 2001). During the same period, average monthly temperatures have increased (see Figure 2a). Since the 1970s, the country has experienced frequent droughts. In addition, the central and northern parts of the country have experienced an increase in flash flooding during the rainy season (World Bank, 2011). Between 1991 and 2009, the country experienced 11 major floods and 3 major droughts (GFDRR, 2011).

Projected Trends. There is a high level of uncertainty associated with climate projections for Burkina Faso and West Africa in general, particularly for changes in rainfall (World Bank, 2011). Models generally agree that annual average temperatures will increase by 3-4°C by the end of the century. The warming is expected to be greatest in the North and more pronounced during the wet season than the dry season (World Bank, 2011). The number of extremely dry and wet years is expected to increase, while semi-arid areas are expected to become more arid (IPCC, 2007). All other things being equal, increasing temperatures will cause greater evapotranspiration, leading to drier soil conditions. However, there is disagreement among models regarding the direction and magnitude of changes in future soil moisture and vegetative cover in the Sahara, due in part to the uncertainty of future precipitation amounts (World Bank, 2011).

3.1.3 NIGER

Niger has a semi-arid tropical climate with rainfall that varies greatly both inter-annually and spatially throughout the country (see the wide range of wetness values in Figure 1). Niger is divided into several climate regions, from North to South: the Saharan desert zone (77% of the country) has rainfall of less than 150 mm/year; the Sahel and Sahara zone has rainfall of 150-300 mm/year; and the Sahel and Sudan zone with rainfall of 600-800 mm/year (NAPA, 2006). Rainfall occurs almost exclusively during the June-September wet season (NAPA, 2006). Temperatures are high throughout the year and range from averages of 18-31°C in the dry season to 28-32°C during the wet season. Extremes of 49.5°C have been recorded (NAPA, 2006).

Observed Trends. Observations demonstrate an overall trend toward greater climate variability, with more frequent droughts, heat waves, floods, and sandstorms; leading to faster drying of water tables, flooding in plains caused by overflow of seasonal rivers, acute erosion due to runoff water, and increased and more virulent bushfires (CIF, 2010). Niger experienced decreased rainfall throughout the 1960s, 1970s, and 1980s that caused severe drought and led to catastrophic failure of harvests, malnutrition, and starvation (NAPA, 2006; CIF, 2010; UNFCCC, 2009). While annual rainfall amounts have recovered slightly since the late 1980s, they are still well below the pre-1960s level (NAPA, 2006). Particularly severe droughts occurred in 1966-1967, 1973-1974, and 1983-1984. The drought of 2004-2005 shows that Niger is still very vulnerable to weak rains.

In the Sahelian zone, observations show the rainy season has shortened in duration, starting later in the year and ending earlier (NAPA, 2006). Annual average maximum and minimum temperatures followed a decreasing trend from 1961-1986, followed by an increasing trend from 1986-2001 (NAPA, 2006).

Projected Trends. Models generally agree that temperatures will increase in Niger, but there is disagreement among the studies on how rainfall and soil moisture may change. Average maximum temperatures are projected to increase by 2.3-2.6°C for the 2020-2049 period compared to the 1961-1990 period, with relatively lower increases during the rainy season (UNFCCC, 2009). Extreme hot days are projected to increase and heavy rainfall events are expected to become more frequent and intense. There is great variability across the climate model projections for annual rainfall, suggesting precipitation results are highly uncertain and should be interpreted cautiously (Reindert et al., 2005). The variation across climate projections suggests that impacts on vegetation could range from gradual desiccation of the entire Sahel region over the next few decades to a humidification process that leads to increased vegetation cover in the region (PPCR, 2006). A study by the AGHRYMET regional center projects a gradual desiccation of the western Sahelian zone and the humidification of the eastern Sahelian zone (PPCR, 2006).

3.2 VALUED ASSETS AND SERVICES: WHAT IS AT RISK

This section summarizes potential climate change impacts on the following key sectors:

- Agriculture and Food Security
- Natural Resources Management
- Water and Water, Sanitation and Hygiene (WASH)
- Health and Nutrition
- Disaster Risk Management
- Rural Infrastructure
- Climate and Early Warning Information

3.2.1 AGRICULTURE AND FOOD SECURITY

Climate shocks and growing demands for natural resources by an expanding population compromise the sustainability of the current systems of land use and seriously threaten food security among rural populations. As noted above, it is unclear whether climate change will increase or decrease rainfall in the region, but it is likely to increase temperatures and the frequency and intensity of extremes. Floods cause less widespread damage than droughts, but can destroy crops and livelihoods in certain areas (weAdapt, 2009; FAO, 2012a). Droughts can result in widespread crop failure, particularly in areas where rain-fed agriculture is the dominant

practice. In addition, successive floods and droughts impact the ability to store food from year to year, resulting in chronic food insecurity. Rainfall variability has provoked a proliferation of locusts since unexpected rainfall can disrupt the dormant state of locusts. Locust invasions are expected to worsen with increasing climate variability, damaging crops and adding stress to food security (UNEP, 2006; FAO, 2012a).

Droughts, floods, heat waves, and dust storms will exacerbate land degradation. Under a changing climate, smallholder farmers may need to shift more towards cultivating crops and varieties that have lower water requirements and are more heat tolerant, such as millet, maize, and cotton (Mohamed, 2002). A continued increase in maximum temperatures and a corresponding increase in evaporation would also affect pastoralist activities by contributing to land degradation and by directly impacting herd mortality rates. The groups that will suffer most from the effects of climate change are the poor, rural populations that are already vulnerable to current climate variations, exacerbated in part through lack of access to the information, capital, and decision-making structures that would allow them to successfully adapt (weAdapt, 2009).

3.2.1.1 BURKINA FASO

Agriculture employs 86% of Burkina Faso's active population. Smallholder, family-based, rain-fed agriculture forms the backbone of the country's economy. Livestock production supplements crop production for livelihood and social returns. In most provinces, millet and sorghum (in sandy uplands and drier areas), maize, and occasionally rice (in low and wet lands) are the main food crops. Other food crops include groundnut, cowpea, sesame, soybean, yam, and sweet potato. Cotton is the main cash commodity crop (CEEPA, 2006). In the southern part of the country, water requirements for cereal crops and groundnut are more easily met by rainfall. In the northern and central regions of the country, water deficits are experienced towards the end of the rainy season and supplementary irrigation is needed (weADAPT, 2009).

Burkina Faso is characterized by chronic food insecurity. The most frequent external shock to food security is drought, which reduces local production and increases demand throughout the region for Burkinabé production (USAID, 2012). According to the national household survey of 2007, more than 38% of households had difficulty satisfying their food needs. Historically, Burkina Faso has relied mostly on extensive agriculture to meet its population's food needs. However, in the past two decades, its population has grown at nearly three percent per year while crop productivity has stagnated. Food security varies greatly between years, as large annual fluctuations in rainfall lead to erratic cereal production. Being a net food importer, food security in Burkina Faso has also been significantly affected by the recent surge in food prices worldwide (World Bank, 2009).

3.2.1.2 NIGER

As of 2011, 14 million people in Niger, out of a total population of 16 million, lived in rural areas (FEWS NET, 2011). The rural population depends primarily on rain-fed agriculture. Millet and sorghum represent about 85% of total food production in Niger, and other crops include cowpea, groundnut, rice, maize, and cotton (Mohamed, 2002). Pastoralism and cultivation of millet and cowpea are predominant in the northern part of the country, which receives less precipitation and experiences greater inter-annual rainfall variability. Cultivation of sorghum and groundnut is predominant in the south. The trend of decreasing rainfall in Niger, resulting in increasingly frequent droughts, coupled with land degradation, extreme maximum temperatures, high evapotranspiration rates, and highly erosive torrential rains present a major challenge to agricultural productivity and food security (Energy SPA, 2006).

While the availability of suitable farm land is diminishing with frequent droughts, rapid population growth has forced agricultural expansion into marginal lands (UNDP, 2009). This variation in climate can largely explain the fluctuating economic growth of the country. Agriculture is an integral part of the Niger economy. The ability of the agricultural sector in Niger to cope with increased temperature and lost agricultural productivity is negligible given the minimal infrastructure resulting from poor investment in the sector (only 2% of the national budget is dedicated to the sector), poor financial resources, and pervasive soil erosion. A decrease in agricultural production is likely to have a negative effect on all other sectors of the economy, thereby potentially threatening the socioeconomic and political stability of Nigerien society. For example, reduced agricultural productivity and an increase in desertification are likely to lead to greater migration of the rural population into cities.

3.2.2 NATURAL RESOURCES MANAGEMENT

3.2.2.1 BURKINA FASO

Burkina Faso has faced degradation of agricultural soils as a result of extreme climate conditions and human activities. Strong population growth has put pressure on natural resources through increased use of extensive agricultural practices, increased deforestation, and overgrazing (GFDRR, 2011). Forests, as well as critical wetlands, are threatened by droughts and heavy precipitation. The country's threatened species include panthers, elephants, crocodiles, and pythons (CBD, 2012).

3.2.2.2 NIGER

Extreme climate conditions in Niger and human activities have contributed to the degradation of agricultural soils and other natural resources. From 1974-2004, Niger suffered severe loss of wetlands as a result of droughts, runoff from torrential rainfalls, and overuse (Republic of Niger, 2009). About 100,000 to 120,000 hectares of forest areas disappear every year, largely due to droughts (Republic of Niger, 2009). Protected areas in Niger cover approximately 8.5 million hectares, equivalent to 6.6% of the national territory and are refuge for many threatened species (CBD, 2012). Small-scale forest management in the past 20 years has helped increase tree coverage in several regions, and fuelwood stocks and fodder supplies have increased as a result (McGahuey and Winterbottom, 2007). However, the increase of population, soil degradation, and climate stresses such as high temperatures, drought, and wildfires will threaten Niger's biodiversity (CBD, 2012). The country also foresees the creation of several fishing reserves to ensure a rational management of aquatic resources.

3.2.3 WATER AND WASH

Population growth, economic development, and climate variability and change present major challenges to water resources managers in Niger and Burkina Faso. These challenges include ensuring adequate access to improved water supply and sanitation to underserved and growing populations, managing increasing demand and competition among water users, and mitigating expected increases in financial, human and economic losses from extreme hydroclimatic events, including floods and droughts. Limited access to water supply and sanitation systems as well as frequent floods and droughts aggravate health conditions and disrupt the livelihoods of rural and urban populations. Diarrhea is a leading cause of childhood mortality in both countries. In addition, surface water supplies are highly interconnected throughout West Africa, which often leads to tensions among states. Long-term declines in water availability, accessibility, and quality may create trans-boundary conflicts or tensions among communities that share and depend on the same water sources.

Rural women and children are particularly sensitive to climate variability and change. Water shortages force women and children to walk increasingly long distances to obtain water (Oxfam Research, 2011).

3.2.3.1 BURKINA FASO

Burkina Faso has experienced large-scale, flood-related disasters in recent decades that have led to deaths, destruction of infrastructure, siltation and sedimentation of lakes and rivers, and pollution of surface waters. The country has also experienced chronic droughts, which have far-reaching effects on the population through effects on water availability and quality. Symptoms include drying of wells, lowering water body levels, increasing pollutant loads, and generally increasing water stress. When water supplies dry, populations, especially in the Central Plateau, migrate to the east and west in search of better living conditions.

Most rivers in Burkina Faso are ephemeral, with the exception of the Mouhoun River (Black Volta) and the Nakambe River (White Volta). Flow in the major rivers has decreased due to dam construction, a change in rainfall regime, and extensive land use changes. Building dams has been the most common way of storing water for the dry season, despite high evaporation rates that are expected to increase as a result of rising temperatures. Burkina Faso has built over 1,500 small dams and is experimenting with artificial rainmaking to try to combat water shortages.

There are disparities between rural and urban access to water supply and sanitation. In 2010, only 50% of urban households and 6% of rural households had access to improved sanitation; while 95% of urban households and 73% of rural households had access to safe water. Standing water, flooding, and poor sanitation leads to disease outbreaks, including malaria, cholera, and diarrhea, respectively. The major limitations to providing safe water and sanitation are the availability of water, funding, and the technological and engineering difficulties of extracting groundwater in Burkina Faso. Increases in rainfall variation could exacerbate the situation.

3.2.3.2 NIGER

Ninety percent of the renewable surface water resources of Niger is generated outside of its borders, most prominently via the Niger River. Flooding in Niger has resulted in loss of life, damage to infrastructure, and river siltation. Prolonged droughts have resulted in a reduction of water availability. Communities in Niger report that there is less water available than there used to be, meaning that wells have to be dug deeper and deeper, and that the onset and cessation of the rainy season are less predictable.

The Niger River flows through the densely populated southwestern corner of the country. The average flow of the Niger has declined throughout the 20th century, from an average of 32 billion m^3 per year from 1930-1960, to an average of 23 billion m^3 in the late 20th century. There is great seasonal variation in the flow, with water levels at Niamey in June averaging less than one third of those in January (CIF, 2010). Climate change, through increases in rainfall extremes, may bring increased erosion, deterioration of water quality, and increased flood risk of the Niger River and its tributaries (IPCC AR4).

There are disparities between rural and urban access to water supply and sanitation. In 2010, only 34% of urban households and 4% of rural households had access to improved sanitation; while 100% of urban households and 39% of rural households had access to safe water (JMPWSS, 2012). As in Burkina Faso, an additional impact of drought in Niger is that women may have to go further to access drinking water, affecting their ability to engage in productive labor. The development of urban water supply and sanitation services in Niger still faces a number of challenges including a high urban population growth rate, the need to

offer affordable access to water supply and sanitation services to unserved urban households, and low-cost solutions to improve access to sanitation.

3.2.4 HEALTH AND NUTRITION

There are two primary climate-sensitive health issues affecting Burkina Faso and Niger: undernutrition and infectious disease. In addition, in the future, there will likely be health issues for "climate migrants" displaced by flood or drought.

Health issues in these countries are exacerbated by the weak capacity of the health system. For example, health indicators in Niger present an alarming situation characterized by very limited access to essential health care, low immunization coverage, and precarious living conditions that strongly impact young child and maternal mortality rates (FAO, 2010). Population dispersion and lack of trained health personnel further impact health care (FAO, 2010).

3.2.4.1 UNDERNUTRITION

Chronic undernutrition and micronutrient deficiencies for Vitamin A, iron, and zinc are significant issues for Burkina Faso and Niger, due to food insecurity and food crises (Lopriore and Muehlhoff, 2003). In 2010, one-fifth of all children treated for Severe Acute Malnutrition (SAM) in the world were located in Niger (Sahel Working Group, 2011). The table below provides undernutrition statistics for both countries from the most recently available Demographic and Health Surveys (2010 for Burkina Faso, 2006 for Niger).

	Burkina Faso	Niger
Percentage of children underweight (-2 SD)	25.7	38.6
Percentage of children stunted (-2 SD)	34.6	54.8
Percentage of children wasted (-2 SD)	15.5	12.4

To the extent that climate change will further stress food security, it will exacerbate under-nutrition. In addition, diarrheal diseases contribute significantly to under-nutrition and have been found to be highly sensitive to increases in rainfall and temperature in children under three (Wang et al., 2009).

3.2.4.2 INFECTIOUS DISEASE

Infectious diseases are another significant health issue in the Sahel. From 2001 to 2008, the World Health Organization reported 28 communicable disease outbreaks in Burkina Faso, including meningitis, yellow fever, measles, and cholera. The incidence of infectious diseases such as meningitis, malaria, and measles are closely tied to climate variables such as temperature, humidity, and precipitation. Climate change will likely cause shifts in the timing, seasonality, and geographic range of disease epidemics, particularly meningitis and malaria. For example, changes in climate appear to be pushing the meningitis belt south (IRIN, 2011). These shifts will likely impact disease prevention and control efforts. Niger's NAPA recognizes the potential adverse effects of climate variability and change on infectious disease, citing an increase in the rate of contracted diseases such as measles, meningitis, malaria, and respiratory diseases as a potential adverse effect of climate change.

3.2.5 DISASTER RISK MANAGEMENT

As noted previously, climate-related disasters are already occurring in Burkina Faso and Niger, with severe consequences for food security, health, and infrastructure. Burkina Faso was one of the World Bank's

Disaster Risk Management team's priority countries for 2009/11. Major disasters in Burkina Faso and Niger include drought (including chronic drought), floods (especially flash floods), disease epidemics, and insect infestations (such as locusts). Storms, bush fires, wind storms, heat waves, and dust storms also affect these countries. Between 1980 and 2010, droughts have affected the most people, epidemics have led to the most deaths, and floods have caused the largest economic damages (PreventionWeb, 2012).

According to the World Bank (2012), droughts and floods can quickly create an emergency situation. Even with continuous foreign aid, food security continues to be an issue. While agriculture often bears the primary brunt of disaster situations, heavy rains can have dire impacts on infrastructure, particularly on poorly constructed informal settlements, the water sector, and infrastructure services. Climate change is likely to exacerbate this situation.

3.2.6 RURAL INFRASTRUCTURE

The vast majority of the region's population remains rural, but urbanization is on the rise. The region's infrastructure, which includes many poorly constructed settlements and roads, remains inadequate and outdated (World Bank, 2011). In 2009, heavy rainfall flooded crops and washed away 22,220 hectares of farmland, broke 15 dams, and destroyed 42,000 homes (World Bank, 2011). The flood in 2009 caused an estimated total damage of USD 102 million, primarily on Burkina Faso's public infrastructure (roads, dams, health facilities) (GFDRR, 2011). Only 17% of all Burkinabés—including 4% of rural households—have access to electricity (World Bank, 2011). Hydroelectricity, generated locally or supplied over inter-connected grids, provides for 6% of total consumption in Burkina Faso and is generated using water resources which are vulnerable to climate change (Helio International, 2009).

The infrastructural developments within the Nigerien oil and gas industry have been part of a wider US$5 billion joint venture between the Nigerien government and China National Petroleum Corporation (CNPC). CNPC has developed the Agadem Oilfield, which utilizes surface engineering infrastructure to extract crude oil and liquefied petroleum gas from the hydrocarbon reserves within the Agadem Block. To link their extraction facilities at the Agadem Oilfield with the Soraz Oil Refinery, China National Petroleum Corporation (CNPC) has also developed the Agadem-Soraz Pipeline. The final part of the joint venture is the Soraz Oil Refinery, which contains the infrastructure necessary to refine up to 20,000 barrels per day of petroleum products (OpenOil, 2012).

3.2.7 CLIMATE AND EARLY WARNING INFORMATION TO SUPPORT DECISION MAKING

Following severe droughts in the 1970s, the Sahelian community banded together to create regional institutions and partnerships that pool resources to minimize the impacts of droughts. Several regional institutions were established that focus in part on strengthening monitoring and early warning systems to provide information to decision makers to enhance preparation and preventive action. Examples of projects run by these institutions include African Monitoring of the Environment for Sustainable Development (AMESD), Vigilance et Gestion Intégrée du Rique Climatique (ViGIRisC), and ClimServ. Other efforts in climate services include ClimDev Africa and the World Meteorological Organization's (WMO) Global Framework for Climate Services, which has chosen Burkina Faso and Niger as pilot countries for development of National Climate Services. Despite progress, generation of climate information is not sufficiently coordinated or harmonized between the major climate institutions in West Africa; technical

services and other end-users are often unaware of climate information; and the information that is being produced often does not sufficiently consider end-user needs, thus constraining potential uptake and use of that information (CCAFS, 2010). In addition, the high cost of meteorological data presents a significant barrier to data access and use by potential end-users, while the costs of generating these data is borne by the governments, which face severe financial strain and therefore view free access to data as untenable (CCAFS, 2010).

3.2.7.1 BURKINA FASO

Interdisciplinary working groups serve as knowledge sharing platforms (e.g. for food security information, providers include the Famine Early Warning Systems Network (FEWS NET), the Direction of Production and Rural Economy (DGPER), and the National Meteorological Service). These working groups consist of members from numerous ministries including the Ministry of Water and the Ministry on the Environment. Forecasts of flood risk, onset of the rainy season, and locust risk are provided by different agencies. The accuracy, timeliness, and usefulness for decision making of these forecasts are often lacking (GFDRR, 2011).

3.2.7.2 NIGER

Recurring food insecurity crises have led the authorities to establish ad hoc management bodies, including the Early Warning System (Système d'Alerte Précoce – SAP), directly connected to the office of the Prime Minister. The SAP focuses primarily on the synthesis of all information produced by different information bodies, to establish a complete picture of the food situation. The 'food crisis task force' was established to deal with crisis management (CIF, 2010). Niger has a national early warning system (EWS/ER) linked with community level committees (SCAP/RU), with council-level vulnerability observatory (OSV), and district-level (sub-regional) committees on prevention and management of food crisis (CSR/PGCA), which is now formally acknowledged at the national level by the DNPGCA (Le Dispositif National de Prévention et de Gestion des crises alimentaires / National Machinery of Food Crisis Prevention and Management) (CARE, 2011). However, Niger suffers from a lack climate data, observational capacity, equipment, financial support, and trained personnel (CCAFS, 2010). Given the size of the country, these factors contribute significantly to inaccuracies in the analysis of climate variability and change and the production of weather forecasts (CIF, 2010).

4. EXISTING EFFORTS AND REMAINING GAPS

4.1 BURKINA FASO

4.1.1 ADAPTATION PRIORITIES

Burkina Faso has articulated its adaptation priorities in three national-level documents: its initial national communication to the UNFCCC (2002), its national strategy (2002), and its National Adaptation Programme of Action (NAPA, 2007). Across these three documents, Burkina Faso prioritizes actions supporting agriculture, water resources, and forestry.

In the country's initial national communication to the UNFCCC in 2002, Burkina Faso identified cotton, forest products, and Ouagadougou drinking water as the top three adaptation priorities. In the national strategy submitted at the same time, Burkina Faso articulated similar priority areas, but generalized them to the agriculture, forestry, and water resources sectors.

Burkina Faso's NAPA, published in November 2007, identified four sectors similar to the two other national-level documents as the most vulnerable: Agriculture, Water Resources, Animal Resources, and Forestry/Biodiversity. The NAPA also identified the most vulnerable populations among poor rural populations: women, children, and small agricultural producers. The NAPA further identified and ranked the top 12 adaptation action priorities:

1. Reinforcement of early warning systems for food security
2. Promotion of supplementary irrigation for grain cultivation
3. Development and management of Lake Oursi
4. Forage production and livestock feed stockpiling
5. Management of natural resources, including development of non-timber forest products
6. Silt deposition prevention
7. Irrigation optimization in four provinces
8. Securing key pastoral areas
9. CES/DES promotion (conservation, protection, and restoration of water and soils)
10. Flora/fauna habitat management
11. Water pollution protection using protected areas, mechanisms, infrastructure
12. Home energy efficiency, renewable energy

The UNFCCC focal point is situated in the permanent secretariat for the National Council for the Environment and Sustainable Development (CONEDD) within the Ministry of the Environment and Quality of Life. This is the only government entity identified as having capacity on climate change, with the issue too often confused elsewhere with general environmental management (weADAPT, 2009).

There are numerous institutions operating regionally and inside Burkina Faso that consider climate change. An illustrative list of these institutions is outlined in the Appendix.

4.1.2 SUMMARY OF ONGOING ADAPTATION PROGRAMS

Action on climate change in Burkina Faso extends beyond the outlining of priorities in the national documents above. However, partly due to the rotation of staff and changing institutional arrangements, action on climate change has been isolated and sector-specific. A 2007 report by DPCIE (Division du Partenariat et de la Coordination des Conventions Internationales en matière d'Environnement) described this situation and stated that there had been no examples of inter-ministerial cooperation on climate change (weADAPT, 2009). The report also stated that, at that time, despite a large number of reports on climate change in Burkina Faso, none of the recommendations of any of the reports had been implemented due in part to the lack of funding.

Below are several examples of adaptation policies and plans:

- The **National Programme for the Rural Sector** (NPRS) includes "the improvement of food and nutritional security and sovereignty in a context of climate change, desertification, and demographic growth" as the first of five broad national guidelines (Oxfam Research, 2011).

- A **UNITAR[3]-funded ACCCA[4] pilot project** aimed to incorporate consideration of climate change variability into the growth and development of Ouagadougou (weADAPT, 2009).
- Institutional **collaboration between National Meteorological and Public Health Services** has promoted climate and health efforts, such as promotion and dissemination of climate and health studies and integration of meteorological forecasting into health decision support tools (Yaka, 2011).
- The government has established **perennial institutions** such as CONEDD and CONASUR (National Council for Emergency Relief and Rehabilitation) to address disaster risk issues (GFDRR, 2011).
- The government has signed and ratified various **international conventions and agreements**, including the three Rio Conventions and the Hyōgo Action Framework (GFDRR, 2011).
- An **Electricity and Infrastructure Strengthening and Rural Electrification Project** aims to rehabilitate and extend national energy generation and the energy grid (World Bank, 2011).
- As of 2009, the **Danish International Development Agency** (DANIDA) was implementing a number of climate-related activities in Burkina Faso, with support programs for the Water and Sanitation, Education, Energy, and Agriculture sectors (weADAPT, 2009).
- UNEP and UNDP started the **Climate Change Adaptation & Development Initiative** (CC DARE program) to integrate climate adaptation into national development plans, with Burkina Faso as one of the target countries (weADAPT, 2009).
- The **Food and Agriculture Organization** (FAO) is involved in early warning and prevention, and provides technical and financial assistance for the National Meteorological Office (weADAPT, 2009).
- Two **International Fund for Agricultural Development** (IFAD) projects, the Community Investment Programme for Agricultural Fertility (PICOFA) and the Sustainable Rural Development Programme (SRDP) intervene in areas characterized by increasing drought, erratic rains, and land degradation to promote soil fertility management, reduce soil erosion, and reverse land degradation using indigenous soil and water conservation techniques (IFAD, 2011).
- The **Africa Adaptation Programme** (AAP) has conducted training on climate analysis; set up a specialized commission on climate change, natural disasters, and scientific monitoring of adaptation; and coordinated with UNDP, GEF, JICA, and the World Bank for the implementation of a programmatic adaptation framework (AAP, 2012).
- The AAP has also assessed national priorities of funds allocated through the **Global Environment Fund** (AAP, 2012). The GEF financed adaptation projects implemented in 2010-2011 that were related to capacity building, biodiversity, and land degradation.
- CARE International is implementing the **Adaptation Learning Program** (ALP) in 20 Nigerien communities in Dakoro District using CARE's community-based adaptation (CBA) approaches to build the capacity of vulnerable households to adapt to the climate change and variation, documenting good adaptation practices and bringing its learning to the national policy level (CARE, 2011).
- GIZ is implementing the **'Sustainable resource management and community development'** project over ten years ending 2015, assisting self-help organizations and the local communities to support social and ecologically sustainable development in three regions (GIZ, 2012).
- The **WB's PPCR** has recently approved financial support of approximately US$100 for four programs: Water Resources Mobilization and Development Project (PROMOVARE), Climate Information Development and Forecasting Project (PDIPC), Community Action Project for Climate

[3] United Nations Institute for Training and Research

[4] Advancing Capacity to Support Climate Change Adaptation

Resilience (through an IBRD loan), and a project preparation grant for the Private Sector Investment to Build Climate Resilience in Niger's Agricultural Sector (through the IFC) (CIF, 2012).

In addition, adaptation is occurring through small-scale, local efforts, including efforts to improve water retention and cultivation resilience to climate variation. For example, farmers use water and soil management and agro-forestry techniques, such as lines of stones, dikes, quickset hedges, windbreaks, zai (micro catchment planting pits), and half-moons (semi-circular earth embankments) (Economic Impact, 2006).

4.1.3 REMAINING GAPS

Climate change efforts need to be fully integrated into the government's institutional framework. The lack of coordination and exchange of knowledge between different Ministries makes it difficult to build an institutional knowledgebase on climate change. It also means that opportunities for synergies are lost. For example, no links have so far been made between CONASUR's activities on disaster risk reduction and climate adaptation. The DPCIE report recommends increased collaboration, both at the national and regional level and the implementation of the Plan for the Environment for Sustainable Development, but it is unclear to what extent the reorganization will facilitate this exchange (weADAPT, 2009). In addition, many of the existing programs lack much-needed financial and operational support. Trained technical experts in climate change should coordinate among institutions with clear mandates.

More specifically, improving climate change resilience in Burkina Faso requires integrated approaches to agricultural production and water resource management, including:

- Intensified efforts to support **water resource and small-scale irrigation development** wherever possible and to promote drought-resistant crops and seed varieties.
- Specific **adaptation activities aimed at women**. Though some efforts have been aimed at poultry-raising, horticulture, and others, the main emphasis of agricultural adaptation activities have been aimed at cereal production, which is generally male-dominated. Women are largely left out of adaptation planning at all levels of decision-making (Oxfam Research, 2011).
- National weather early warning systems, environmental monitoring, research on best practices, increased technical capacity, financial lending, water storage, crop diversification, soil restoration (GFDRR, 2011).

Disaster risk reduction must also be integrated with climate change management. Importantly, the functions of CONASUR and CONEDD should be integrated. Other DRR needs include:

- **Coordinated training programs** devoted to capacity building in the area of disaster risk reduction and climate change.
- **Mechanisms for rapid assistance** to those affected by natural disasters, including floods and droughts, such as monitoring capabilities and institutions responsible for addressing natural disaster risk.

Finally, infrastructure must be improved to better withstand the wet season, including better spatial management of rural and urban areas, as well as improved housing construction materials, design, and locations. Dams and drainage systems should also be strengthened so that intense rainfall does not easily overwhelm and break those systems.

4.2 NIGER

4.2.1 ADAPTATION PRIORITIES

Niger's adaptation priorities are described in their Second National Communication on Climate Change (2009) and National Adaptation Programme of Action (NAPA, 2006). Niger's priority investments lie primarily in the agriculture and food security sectors. Other adaptation priorities are in health and natural resources.

The NAPA took into consideration five important criteria for identifying priority adaptation measures: impact on groups and vulnerable resources; cost; impact on economic growth rate of the poor; avoided losses for the poor; and synergy with the multilateral and environmental agreements, projects, and national programs.

The top priorities listed in the NAPA in order of importance are:

1. Introducing fodder crop species in pastoral areas
2. Creating livestock food banks
3. Restoring basins for crop irrigation
4. Diversifying and intensifying crop irrigation
5. Promoting peri-urban market gardening and livestock farming
6. Promoting income-generating activities and developing mutual benefit societies
7. Water control
8. Producing and disseminating meteorological data
9. Creating food banks
10. Contributing to fight against climate-related diseases
11. Improving erosion control, water harvesting and conservation measures for agricultural, forestry, and pastoral purposes
12. Dissemination of animal and crop species that are most adapted to climatic conditions
13. Watershed protection and rehabilitation of dump-off ponds
14. Building of material, technical, and organizational capacities of rural producers

These priority measures are aligned with the country's Poverty Reduction Strategy (2002) and Rural Development Strategy (2003) with regard to food security, capacity building, water control, prevention of desertification, and the promotion of income-generating activities (NAPA, 2006).

There are numerous institutions operating regionally and inside Niger that consider climate change. An illustrative list of these institutions is outlined in the Appendix.

4.2.2 SUMMARY OF ONGOING ADAPTATION PROGRAMS / EFFORTS

Niger is implementing actions related to the NAPA's listed priorities. The initiatives focus on adaptations to address agricultural challenges, food crises, and natural resource degradation. A project titled "Implementing NAPA Priority Interventions to Build Resilience and Adaptive Capacity of the Agriculture Sector to Climate Change" is underway (GEF, 2009).

Several plans are in place to address agriculture and food security. Niger developed a National Agricultural Investment Plan (NAFSIP) in June 2010 designed to increase resiliency in the agricultural sector (FAO, 2012). Over a dozen programs were identified to achieve the goals of improvement of food security and

reinforcement of physical, economic, and social assets for vulnerable groups. The programs will be gradually integrated with several ongoing activities and future actions. Key activities in the Plan include improving soil fertility, water management, reforestation, and ecosystem preservation. Additionally, the Regional Working Group on Food Security and Nutrition developed a strategic document in December 2011 to prepare for a food crisis in the Sahel (Relief Web, 2011). Recommendations included increasing efficiency of locust control operations in Niger and closely monitoring the growing season (FAO, 2012a).

Niger is relatively far along in responding to food crises. According to the Integrated Regional Information Networks (IRIN, 2012), Niger has used sophisticated early warning systems related to nutrition, improved the nutrition response system, and scaled up nutrition training since the 2010 drought crisis. Niger is implementing some pilot adaptation projects and developing climate change strategies and frameworks to address climate-related food crises through the African Adaptation Programme (AAP).

The Government of Niger's commitment to investment in natural resource management is expected to gradually address food security and mitigate the impact of climate shocks on agricultural production (FAO, 2012). Since farmer-managed natural forest regeneration (FMNR) was first piloted in the 1980s, this simple, low-cost technique has greatly helped to mitigate land degradation. FMNR relies on farmers to manage the natural regeneration of trees and shrubs. The roots minimize soil erosion and improve soil fertility, and the branches are used for firewood, leading to positive impacts on agro-ecological conditions and on food security in Niger (WRI, 2008).

Several existing programs contribute to improving the resilience of natural systems including the Niger River Basin, Niger Valley, Lake Chad Basin, and Zinder and Diffa Regions. Furthermore, current investments in infrastructure in Niger such as construction of dams, sewers and watershed protection works, deepening ponds, and strengthening access roads will enhance climate resiliency across multiple sectors (CIF, 2010).

Other small-scale initiatives supported by national and international NGOs target the following areas (CIF, 2010):

- **Biodiversity**, e.g., agricultural land and grazing areas reclamation, protection of river banks, dune protection, and development of ponds (CARE International)
- **Rehabilitation of livelihoods affected by drought** and assistance to vulnerable population to cope better with future crises (Oxfam)
- **Disaster and humanitarian emergency response** (World Vision)
- **Children's access** to nutritious food and to healthcare (Save the Children)
- **Rehabilitation of pastoral and agro-pastoral** production and livelihoods (AREN)
- **Savings and micro-credit** programs (Karkara)

4.2.3 REMAINING GAPS

Even with planned adaptation actions focused on agriculture, rural communities are still vulnerable to low rainfall amounts such as those during the 1960s through 1980s. Practices such as the use of drought-resistant seed varietals, agriculture diversification, integrated pest and disease management, and improved water harvesting technologies can improve Niger's climate resilience in its agricultural sector (FAO, 2012).

Resilience in the health sector can be enhanced through promotion of epidemic prevention and control measures, capacity building to monitor and manage climate-sensitive disease epidemics, establishment of a system to communicate information about epidemics, and systematic vaccinations (Republic of Niger, 2009).

Institutional gaps can be addressed by close collaboration between development partners and the Government of Niger. For example, the National Technical Commission on Climate Change and Variability (CTNCVC) is made up of 29 members from state institutions, private organizations, and civil society and deals with priority issues such as agriculture, livestock, energy, water, and infrastructure. However, since its creation in 1997, the CTNCVC has only been able to organize two general meetings, though its operational Executive Secretariat comprised of government officials only and which works through seven inter-ministerial technical commissions has met more frequently.

Furthermore, the country's institutions will need to develop approaches and financial tools to raise more funds and manage expenditures, and to ameliorate the effects of development partners' 'stop and go' policies. Financial resources are a major impediment for adaptation efforts. The amount of financing for Niger's NAFSIP/RDS investments and programs for the 2006-2015 period is estimated at US$4.156 billion, of which US$2.964 billion of financing has not been committed (FAO, 2012).

5. RECOMMENDATIONS TO INCREASE CLIMATE RESILIENCE

The national governments of Burkina Faso and Niger should continue to strengthen their long-term climate policies, based upon input from a broad range of constituencies. These policies need to be fully implemented. The national policies should be infused throughout the countries' legal and regulatory frameworks across all sectors.

The policies should ensure that national-level management effectively empowers regional and local decision making and initiative to address the uniqueness of the challenges and to capitalize on the insights and traditional capabilities that exist at those scales. Adaptation planning needs to be mainstreamed into the planning structures of local government structures, as well as central and local budgeting mechanisms.

There is a need for improved sharing of knowledge and better coordination between ministries and programs within these two countries. Synergies between programs, coordination between different stakeholder groups, and improved monitoring and evaluation mechanisms will facilitate mainstreaming climate resilience into programs across sectors. There are also certain sectors, such as transport, where strategic priorities are less well understood than in others, such as sustainable land and water management (World Bank, 2012).

The national governments should actively coordinate the complex set of development partners. They should help to ensure that the appropriate sets of resources are brought to bear (e.g., unilateral funding, basket funding, microfinance, insurance, non-monetary resource support, etc.). The approaches should be designed to be robust in the face of the potential for intermittency of funding from within the country and from donors (FAO, 2012).

Institutional strengthening and capacity building within the two governments and their civil societies to use and interpret the latest available information is important. Toward that end, enhancements to training, extension, and research will be vital, particularly through facilitation from NGOs and development partners. Enhancements to hydrometeorological networks and services would provide an essential underpinning for this enhanced capacity.

Particular attention should be given to providing effective social protection mechanisms for the most vulnerable (World Bank, 2012). Specific adaptation activities aimed at women should be enhanced. For example, there is some indication that when women are organized into an association at the community level, they are much more likely to be consulted and to benefit from that consultation (Oxfam Research, 2011).

5.1 AGRICULTURAL ADAPTATION

Given the rural, subsistence nature of the populations in Burkina Faso and Niger and their high levels of vulnerability, the most important adaptation entry points should be farmers and extension agencies (most likely through the work of rural-focused NGOs). Farmers' traditional knowledge and skills that have allowed them to survive in marginally productive environments can be the most efficient starting point for upgrading and disseminating adaptation measures.

Agricultural adaptation can be advanced by promoting:

- **Farmers' participation** in climate-related decision support systems (Roncoli et.al., 2008).
- **Urban agricultural upgrading** including integration into urban food value chains
- **Enhancements to irrigation systems**, optimization of water use in irrigated fields, and enhancements to rainwater capture and storage
- **Secure pastoral areas** and strategic pastoral spaces (e.g., access to water)
- **Changes in the use of fertilizers** (e.g., composting, mulching, and placing animals in the fields to provide manure directly)
- **External interventions** in the form of new information and technology aimed at improving effective coping capacities, institutional coordination for better articulation (connections among institutions) and improved access (connections of institutions with social groups), and inflows of financial support for local leadership (Agrawal, et. al., 2008)
- **Strengthening of early warning systems** for weather-, water-, and climate-related hazards, improving communications and notifications to farmers regarding climate (seasonal) and hydrological forecasts (drought, floods, and pests), and harmonizing information databases and methodologies (Burkina Faso, Climate Risk and Adaptation Country Profile, 2011; weAdapt, 2011)
- **Use of more resilient crop seeds** (e.g., drought and heat resistant varietals) **and cropping techniques** (e.g., inter-cropping and crop rotation) (Conservation des Eaux et des Sols/Défense et Restauration des Sols)
- **Extension of adapted approaches for sustainable crop intensification** such as integrated water management, integrated soil fertility, integrated pests and disease management, and desertification control (e.g., growing hedges and using trees as wind-breaks to reduce erosion; water harvesting techniques such as digging pits to encourage infiltration into soil) (Sissoko, et al., 2010)
- **Agreements between agriculturalists and pastoralists** to provide fodder for livestock in return for remuneration have been shown to work well, and benefit both parties
- **Replacement of cows with goats and camels**, which are better adapted to drier conditions
- **Additional research** on the impact that climate change will have on livestock (Thornton et.al., 2007)

- **Agriculture diversification** and off-farm income diversification

5.2 FOOD SECURITY ADAPTATION

In addition to the above, the following measures are needed for improved food security:

- **Promotion of decentralized food stocks** (e.g., cereal banks)
- **Consumption of non-traditional food plants**
- **Improvements in preparedness, communication, and management** of food stock distribution during crises
- **Citizen education and training** on how to deal with the risk of food insecurity

5.3 NATURAL RESOURCE MANAGEMENT ADAPTATION

Adaptation options for natural resource management include:

- **Regreening—**this should remain a top priority. Farmer-managed natural forest regeneration as well as planted tree crops have been shown to yield higher household incomes, improved crop yields and food security (especially with the use of leguminous trees), diversified household production and marketable products, and reductions in women's time to collect wood fuels allowing it to be used for more productive outlets.
- **Improved management to promote a diverse natural vegetation**, including through development of non-timber forest products
- **Soil fertility and erosion management** to help reverse land degradation (IFAD, 2011)

5.4 WATER SYSTEM ADAPTATION

Adaptation options in the water sector include:

- **Increased use of Integrated Water Resources Management** principles
- **Measures to protect against stream pollution** that arise from climate extremes (both low and high flow conditions).
- **Enhancements to water storage and treatment infrastructure**
- **Increased use of techniques for enhancing water capture** (e.g., zai, revegetation)
- **Promotion of low-cost, climate resilient sanitation technologies**

5.5 URBAN POPULATION ADAPTATION

Adaptation options in the urban sector include:

- **Improved land-use planning and zoning**
- **Combating water pollution** in overburdened and inefficient water systems
- **Improving waste management and urban sanitation**
- **Strengthening awareness** and development of long-term strategies to reduce urban flood risk

5.6 HEALTH ADAPTATION

Adaptation options in the health sector include:

- **Enhanced collaboration** between climate information providers and public health services
- **Increased investment** in nutrition response systems
- **Building the capacities to increase understanding** (via research and training) and collect data necessary for managing climate-sensitive disease epidemics
- **Promotion of climate-related epidemic prevention and control** measures
- **Sensitization of the populations** for the protection and prevention against climate-sensitive diseases

5.7 INFRASTRUCTURE ADAPTATION

Stronger rural infrastructure could substantially decrease the population's vulnerability to weather shocks by increasing the range of income-generating activities and by allowing aid to reach remote villages (World Bank, 2011). Implementation of cost-effective risk transfer and risk reduction measures such as the provision of "safety nets" and the development of early warning systems should be a priority. To reduce the loss of lives and destruction of infrastructure during the wet season, spatial management of rural and urban areas as well as housing construction materials, design, and locations need to be improved. Enhanced urban and rural land-use planning remain critical in the long term. Dams, drainage systems, and roads should also be strengthened so that intense rainfall does not easily overwhelm and break these systems.

5.8 DISASTER RISK REDUCTION ADAPTATION

Government sector ministries need to incorporate risk reduction of hazards and vulnerabilities into future planning. This should be complemented by concrete actions, including improvements to mechanisms for rapid assistance to those affected by climate-related natural disasters (e.g., floods and droughts). Establishment of better multi-sector coordination within the ministries and key-stakeholders is needed to ensure a common approach in disaster risk reduction. Programmatic efforts to reduce climate vulnerabilities should be synergized with those to reduce risks from the full range of disasters. Improvements in institutional capacity for hazard monitoring and response are essential. This can be enabled in part through establishment of training programs that bridge between disaster risk reduction and climate change. Early warning systems need to be enhanced to ensure early action occurs in communities, through improved and more timely communications and use of ICTs.

6. ANNOTATED BIBLIOGRAPHY

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Mª Romero González, A., Belemvire, A., and Sauliére, S., 2011. *Climate change and women farmers in Burkina Faso: Impact and Adaptation Policies and Practices*. Oxfam, Oxford, UK. Available at: http://www.oxfam.org/sites/www.oxfam.org/files/rr-climate-change-women-farmers-burkina-130711-en.pdf. This document analyzes the specific impact of climate change on women in Burkina Faso's agricultural sector, as well as how gender and women are taken into account in national adaptation and rural development policies and programs. It also examines adaptation practices aimed at women and the outcomes of such practices in terms of both gender and adaptation.

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Ouedraogo, Mathieu, et al. 2006**.** *Economic Impact Assessment of Climate Change on Agriculture in Burkina Faso: A Ricardian Approach.* CEEPA Discussion Note No. 24. CEEPA, South Africa. Available at: www.ceepa.co.za/docs/cdpno24.pdf. This study aims to assess the impact of climate change on agriculture in Burkina Faso. It uses the Ricardian cross-sectional approach to measure the

relationship between climate and net revenue from growing crops. It regresses the net revenue of crops on several variables: climate, soil, relevant hydrology, and socio-economics. It tests three models: one without adaptation, one with adaptation, and one with a dummy zone variable). From the estimated models, we determine the marginal climatic effects and their elasticity in order to examine the sensitivity of net revenues from crops to temperature and precipitation. The study determines how Burkina Faso farms would respond to climate change based on the Intergovernmental Panel on Climate Change scenarios (IPCC) and scenarios of the hydrology component of the GEF/World Bank Project, Regional Climate, Water and Agriculture: Impacts on and Adaptation of Agro-ecological Systems in Africa.

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PreventionWeb. 2010b. *Niger – Disaster Statistics*. PreventionWeb. Available at: http://www.preventionweb.net/english/countries/statistics/?cid=125. This resource provides data related to human and economic losses from disasters that have occurred between 1980 and 2010 in Niger.

Relief Web. 2011. *UN launches a strategy to better respond to the risk of a new food and nutritional crisis in the Sahel in 2012*. Available at: http://www.fao.org/fileadmin/user_upload/sahel/docs/FAO_WFP_joint_Note_Sept_Oct_2012.pdf. This press release announces the development of a strategic document to prepare for a Food and Nutrition crisis in the Sahel and neighboring countries in the first half of 2012. The objective of this strategic document aims at reinforcing preparedness to ensure a rapid, efficient and early response.

Republic of Niger. 2006. *National Adaptation Programme of Action (NAPA)*. Republic of Niger, Global Environment Facility, and United Nations Development Programme. Available at: http://unfccc.int/resource/docs/napa/ner01e.pdf. This report identifies the sectors, communities,

and areas that are most vulnerable to climate change in Niger. It identifies adaptation priority needs in key sectors, and suggests 14 adaptation options that respond to the most urgent and immediate needs to adapt to climate change in the country.

Republic of Niger. 2009. *Niger Second National Communication on Climate Change*. Republic of Niger, Global Environment Facility, and United Nations Development Programme. Available at: http://unfccc.int/resource/docs/natc/nernc2e.pdf. This document provides information on Niger's country characteristics, greenhouse gas emissions profile, and climate change impacts and vulnerability. It suggests measures to mitigate and adapt to climate change, and identifies the constraints, priority needs, and funding needs to implementing these measures.

Sahel Working Group. 2011. *Escaping the Hunger Cycle: Pathways to Resilience in the Sahel.* Available at: http://www.e-alliance.ch/fileadmin/user_upload/docs/Publications/Food/2012/Escaping_the_Hunger_Cycle_English.pdf. This report is a detailed analysis of changes in policies and programs in the Sahel since 2005. It assesses the extent to which lessons of the 2005 food crisis were applied during the crisis of 2010. Commissioned by the Sahel Working Group as a follow-up to an earlier study *Beyond Any Drought*, the initial central question guiding this study was: 'what lessons have been learned since 2005 about what has to change in the Sahel, so that every drought does not result in a new humanitarian crisis?' *Beyond Any Drought* assessed the root causes of chronic vulnerability in the Sahel. The focus of this follow up study is to determine how aid can be more effectively used to reduce vulnerability in the Sahel.

Smith, B., 2009. *National Adaptation Planning: Burkina Faso*. weADAPT. Available at: http://weadapt.org/knowledge-base/national-adaptation-planning/burkina-faso. weADAPT's country profile of Burkina Faso provides an overview of historic and probable future climate change impacts, citing droughts, floods, heat waves, and dust storms as major climatic hazards. These hazards have the potential to affect agriculture and health in Burkina Faso. The profile therefore outlines a number of adaptation and mitigation measures undertaken by the government, non-governmental institutions, donors, and indigenous groups that have shown promising results.

Smith, B., 2011. *National Adaptation Planning: Niger*. weADAPT. Available at: http://weadapt.org/knowledge-base/national-adaptation-planning/niger. weADAPT's country profile of Niger provides an overview of historic and probable future climate change impacts on agriculture, health, and social systems in the country. Such impacts include floods, droughts, and precipitation variability. Additionally, it includes temperature and precipitation projections into 2065 and offers potential adaptation measures that have been proposed in recent research for communities to cope with anticipated climate variability.

Sparacino, C., 2011. *Regreening the Sahel: Developing agriculture in the context of climate change in Burkina Faso*. IFAD, Italy. Available at: http://www.ifad.org/operations/projects/regions/pa/infosheet/sahel.pdf. This information sheet provides information on climate information and impacts on sectors that are most vulnerable to climate change in Burkina Faso. It also provides adaptation measures necessary to cope with these impacts and explains several examples for doing so, including improved farming and water conservation practices.

Tappan, G., 2011. *African Re-Greening Initiatives Update*. USGS-EROS, Washington, DC. Available at: http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&ved=0CC4QFjAA&url=http%3A%2F%2Fframeweb.org%2Fcadl%2Fen-US%2Fc%2F7059%2Fet%2Fcontribution%2Fct%2F225%2Fsn%2FDocument%2F7246%2Ffile%2F977%2FARI%2520update%25202011%2520no.4.doc&ei=rcejUOzfMqbs2QW7hAE&usg=AFQjCNEOh3snEcX6d7vnkwy6DzgR0pE5pQ. Gray Tappan used high resolution satellite images to uncover the scale of this young agroforestry parkland, though more research needs to be done about its history, evolution, and dynamics. SahelECO and its partners continue to promote farmer-managed re-greening in this region and elsewhere in Mali. Where a set of conditions are united, it is possible to induce farmers to invest in on-farm trees and transform landscapes and production systems at scale.

U.S. Department of State. 2012. *Background Note: Burkina Faso*. Available at: http://www.state.gov/r/pa/ei/bgn/2834.htm. This Note provides an overview of the geography, history, and political and socio-economic conditions of Burkina Faso.

UNFCCC, 2001. *Burkina Faso UNFCCC National Strategy*. United Nations Framework Convention on Climate Change. Available at: http://unfccc.int/resource/docs/natc/bufstrat.pdf. This strategy includes information on emissions and removals of greenhouse gases and details of activities Burkina Faso has undertaken to adapt to climate change. Information is also provided on vulnerability assessments and other related policies and measures.

United Nations Development Program (UNDP). 2012a. *Africa Adaptation Programme: Niger*. Available at: http://www.undp-aap.org/countries/niger. This webpage provides an overview of the socio-economic profile, climate vulnerability profile, and national adaptation strategy of Niger. It also features Africa Adaptation Programme's recent activities in Niger and links to additional information and resources.

United Nations Development Program (UNDP). 2012b. *Africa Adaptation Programme: Burkina Faso*. Available at: http://www.undp-aap.org/countries/burkina-faso. This webpage provides an overview of the socio-economic profile, climate vulnerability profile, and national adaptation strategy of Burkina Faso. It also features Africa Adaptation Programme's recent activities in Burkina Faso and links to additional information and resources.

United Nations Development Program (UNDP). 2012c. UNDP Africa Adaptation Programme (AAP) Document: Niger, Draft 0.1. Available at: https://www.undp-aap.org/sites/undp-aap.org/files/Niger.pdf. This document provides detailed descriptions of the project "Supporting Integrated and Comprehensive Approaches to Climate Change Adaptation in Africa," which aims to mainstream climate change adaptation across key sectors and into development processes in Niger.

United Nations Environment Programme (UNEP). 2006. *Africa Environment Outlook 2– Our Environment, Our Wealth. Sub-regional Scenarios: Western Africa*. Available at: http://www.unep.org/dewa/Africa/publications/AEO-2/content/264.htm. This report profiles Africa's environmental resources as an asset for the region's development and how they are affected by stressors. Agricultural production in West Africa is a primary sector, and food security will be vulnerable to climate impacts.

United Nations Environmental Program (UNEP) and World Agroforestry Center. 2006. *Climate Change and Variability in the Sahel Region: Impacts and Adaptation Strategies in the Agricultural Sector*. UNEP, Nairobi, Kenya. Available at: http://www.unep.org/ecosystemmanagement/LinkClick.aspx?fileticket=7hsB6mTyaHo%3D&tabid=315&language=en-US. This paper documents some of the mechanisms the Sahelian communities have used to cope with current climate variability, and the contribution of scientific research and technological innovations in addressing the major constraints of drought, land degradation and desertification. The assumption is that if these indigenous resources and technological innovations are effective to cope with current climate variability and other constraints, they will probably be useful to deal with future climate change. The paper analyzes these adaptive resources, identifies the obstacles and knowledge gaps, and provides recommendations to make agriculture in the Sahel more resilient to climate change.

USAID, 2012. *Cooperation Framework to Support the New Alliance for Food Security & Nutrition in Burkina Faso*. USAID, Washington, DC. Available at: http://growafrica.com/wp/wp-content/uploads/2012/04/Burkina-Faso-Coop-Framework-ENG-Final-w.cover_1.pdf. This report states G8 members' support of the Comprehensive Africa Agriculture Development Program (CAADP) in demonstrating African ownership and leadership, its call for expanded public and private investment in agriculture and desire to build on the progress that African governments have made in advancing a vision for agricultural development in Africa. The Government of Burkina Faso and the G8 members commit to the "New Alliance for Food Security and Nutrition" and to working together to generate greater private investment in agricultural development, scale innovation, achieve sustainable food security outcomes, reduce poverty, and end hunger. As partners, they commit themselves to the support CAADP country compacts, key policy commitments, private sector engagement, shared responsibilities, coordination and collaboration, and mutual accountability.

Wang, L., Kanji, S., and Bandyopadhyay, S. 2009. *The Health Impact of Extreme Weather Events in Sub-Saharan Africa*. World Bank, Policy Research Working Paper No. 4979. Available at: http://elibrary.worldbank.org/docserver/download/4979.pdf?expires=1352926734&id=id&accname=guest&checksum=301F4CC5155481F21C91D87EF61B764A http://elibrary.worldbank.org/content/workingpaper/10.1596/1813-9450-4979. This paper quantifies the impact of extreme rainfall and temperature events on the incidence of diarrhea, malnutrition, and mortality in young children in Sub-Saharan Africa. The results show that both excess rainfall and extreme temperatures significantly raise the incidence of diarrhea and weight-for-height malnutrition among children under the age of three, but have little impact on the long-term health indicators, including height-for-age malnutrition and the under-five mortality rate. The authors use the results to simulate the additional health cost as a proportion of gross domestic product caused by increased climate variability. The projected health cost of increased diarrhea attributable to climate change in 2020 is in the range of 0.2 to 0.5 percent of gross domestic product in Africa.

World Bank. 2012a. *Climate Change Knowledge Portal: Burkina Faso Dashboard*. Available at: http://sdwebx.worldbank.org/climateportalb/home.cfm?page=country_profile&CCode=BFA. This dashboard provides an overview of the socio-economic and natural hazard profile of Burkina Faso. It features information on the country's climate baseline and future, climate change impacts and

vulnerabilities, as well as adaptation options by sector, priority adaptation projects, and adaptation gaps and needs. The dashboard is periodically updated to reflect the most recent publicly available climate analysis.

World Bank, 2012b. *Niger Country Brief*. The World Bank. Washington, DC. Available at: http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/NIGEREXTN/0,,menuPK:382460~pagePK:141132~piPK:141107~theSitePK:382450,00.html. This country brief explains the World Bank's work with Niger, as well as the country's political and economic contexts. The strategies, results, and partners of projects in numerous sectors including agriculture, roads, and water management are discussed.

World Bank. 2012c. *Climate Change Knowledge Portal: Niger Dashboard.* Available at: http://sdwebx.worldbank.org/climateportal/index.cfm?page=country_historical_climate&ThisRegion=Africa&ThisCCode=NER. The dashboard provides an overview of the socio-economic and natural hazard profile of Niger. It features information on the country's climate baseline and future, climate change impacts and vulnerabilities, as well as adaptation options by sector, priority adaptation projects, and adaptation gaps and needs. The dashboard is periodically updated to reflect the most recent publicly available climate analysis.

World Bank. 2011. *Vulnerability, Risk Reduction, and Adaptation to Climate Change: Burkina Faso*. Climate Risk and Adaptation Country Profile Series. World Bank, Global Facility for Disaster Reduction and Recovery, Climate Investment Funds, and Climate Change Team ENV, Washington, DC. Available at: http://sdwebx.worldbank.org/climateportalb/doc/GFDRRCountryProfiles/wb_gfdrr_climate_change_country_profile_for_BFA.pdf. This profile synthesizes the most relevant data and information for Disaster Risk Reduction and Adaptation to Climate Change in Burkina Faso. It covers climate baseline and future; climate change impacts on natural hazard vulnerability; climate risk impacts and reduction recommendations in key sectors; implications for disaster risk management and adaptation; and research, data, and information gaps. Sources on climate and climate-related information are linked through the country profile's online dashboard (http://sdwebx.worldbank.org/climateportalb/home.cfm?page=country_profile&CCode=BFA), which is periodically updated to reflect the most recent publicly available climate analysis.

World Bank. 2010. Local Development, Institutions, and Climate Change in Burkina Faso: Situation Analysis and Operational Recommendations, the World Bank, Washington, DC. Available at: http://siteresources.worldbank.org/EXTSOCIALDEVELOPMENT/Resources/244362-1232059926563/5747581-1239131985528/5999762-1242914244952/BurkinaReportFinal_EN.pdf. This paper aims to examine the particular situation of Burkina Faso and describe its major economic, ecological and weather features. Major institutional local development stakeholders are also identified, as well as key features of local development, major political and operational frameworks, and vital aspects of development planning and management. The paper defines the role played by institutions (both public and private, formal and informal, national and local) in disaster response and support to local adaptive strategies, and makes recommendations for World Bank operations in Burkina Faso.

World Bank. 2009. Project Appraisal Document on a Proposed Grant in the amount of US$40 million to Burkina Faso for an Agricultural Productivity and Food Security Project. This document provides information on the Agricultural Productivity and Food Security Project (2009-2015) in Burkina Faso. The project consists of three components: i) improving food production, ii) improving the availability of food products, and iii) institutional development and capacity building.

World Health Organization (WHO) and World Meteorology Organization (WMO). 2012. *Atlas of Health and Climate*. WHO/WMO, Geneva, Switzerland. Available at: http://www.who.int/globalchange/publications/atlas/report/en/index.html. This Atlas provides sound scientific information on the connections between weather and climate and major health challenges. These range from diseases of poverty to emergencies arising from extreme weather events and disease outbreaks. They also include environmental degradation, the increasing prevalence of non-communicable diseases, and the universal trend of demographic ageing. The Atlas includes information on the "Meningitis Belt" in sub-Saharan Africa, which includes Niger and Burkina Faso.

World Meteorological Organization, 2008. *Capacity Assessment of National Meteorological and Hydrological Services in Support of Disaster Risk Reduction*. World Meteorological Organization, Geneva, Switzerland. Available at: http://www.wmo.int/pages/prog/drr/documents/CR/_TOC.pdf. This report explored survey responses from 28 African National Meteorological and Hydrological Services (NMHSs), which indicated that there are widespread deficiencies in hydrometeorological observing networks, telecommunications, and informatics systems in Africa and very limited NMHS capacities in data management and product customization.

World Resources Institute (WRI). 2008. *Building Resilience to Climate Change in Niger*. Available at: http://www.wri.org/stories/2008/08/building-resilience-climate-change-niger. This article describes how Niger is building resilience to climate change through an unprecedented, farmer-led "re-greening" movement that has reversed desertification and brought increased crop production, income, food security, and self-reliance to impoverished rural producers.

Yaka, P (Burkina Faso Meteorological Office). 2011. *Climate information for Meningitis early warning and control in Burkina Faso: Duties and achievements*. PowerPoint presentation. Climate and Health in Africa 10 Years On, April 04-06, 2011, Addis Ababa, Ethiopia. This document summarizes the influence of climate factors on meningitis in Burkina Faso, and presents actions that have been taken to address climate change impacts on health in the country. These actions include cooperation between the National Meteorological Office and Public Health Services; cooperation with national, regional, and international climate projection centers; higher education training on climate sensitive diseases, and establishment of the "Environment and Bioclimatology Desk" in the Meteorological Office.

7. APPENDIX

7.1 SUMMARY OF KEY REGIONAL AND NATIONAL INSTITUTIONS THAT OPERATE IN SECTORS RELATED TO CLIMATE CHANGE (PRIMARY SOURCE: CARE, 2011)

Institution	Mandate / mission / interest for CC	Other information
REGIONAL INSTITUTIONS		
Agrhymet Regional Center (ARC)	- Provide information and training for development players in the fields of agro-climatology, hydrology and plant health and management of natural resources - Regional Center of Excellence in matters pertaining to : ✓ Training of senior staff from Sahel countries and elsewhere ✓ Agro-meteorological and hydrological supervision at the regional level ✓ Agricultural statistics and farming supervisions ✓ Regional data banks ✓ Management and dissemination of information on the supervision of natural resources in Sahel ✓ Enhancement of Inter-States cooperation through exchange of methodology and technologies; etc.	- Head Office in Niamey ; created in 1974 - Specialized institution of the Inter-States Permanent Committee on Fight against Drought in the Sahel Region[5] (CILSS) created in 1974 - Inter-state public institution which has a legal personality and financial autonomy - Has the status of an *international organization*
African Center for Weather Applications for Development (ACMAD)	- Develop and transfer tools and technologies towards national weather systems - Develop information and weather and climate products to encourage sustainable development - Transmit weather and climate information to users mainly in rural areas - Ensure current activities of (i) climate watch, (ii) seasonal forecast (iii) climate forecast and (iv) training of African meteorologists on new techniques and technologies ; etc.	- Created in 1987 by the Conference of Ministers of the Economic Commission for Africa (ECA) and the World Weather Organization (WWO) - Head Office in Niamey - Constituted of all the 53 African countries

[5] CILSS has nine member countries : Burkina Faso, Cape Verde, Gambia, Guinea-Bissau, Mali, Mauritania, Niger, Senegal and Chad

Institution	Mandate / mission / interest for CC	Other information
International Crops Research Institute for Semi-Arid Tropics (ICRISAT)	- Assist 600 million poor people to overcome hunger, poverty and environmental degradation in semi-arid tropics thanks to a more efficient agriculture - Carry out fundamental research in the following fields: ✓ Agronomy ✓ Pedology ✓ Genetic improvement of millet, groundnuts and sorghum ✓ Geographical Information Systems (GIS) - Engage an active collaboration with national agronomical research institutions, diverse networks, regional forums, advanced research institutes, NGOs, association of producers and the private sector	- A non-profit making and a nonpolitical international Organization which does agricultural research - Innovative and capacity building for sustainable development in 20 countries in tropical semi-arid areas of Western Africa - Member of the network "Future Harvest" initiated by the Consultative Group on International Agricultural Research (CGIAR) - ICRISAT is comprised of three centers which include the Regional Center for West Africa based in Niamey - Other research centers are based in Bamako (Mali) and in Kano (Nigeria)
Niger River Basin Authority (ABN)	- Ensure integrated development of the Basin by developing its resources in several fields (energy, agriculture, livestock, fishing, logging, etc.) - Promote implementation of the Shared Vision between States for sustainable development of the Basin - Support national structures within the framework of hydrological observations	- ABN brings together nine member States : Burkina Faso, Benin, Cameroon, Côte d'Ivoire, Guinea, Mali, Niger, Nigeria, Chad
Famine Early Warning System Network (FEWSNET)	- An information system designed to identify problems in the food supply system that potentially lead to famine or other food-insecure conditions in sub-Saharan Africa and elsewhere - Goal is to lower the incidence of drought- or flood-induced famine by providing to decision makers, timely and accurate information regarding potential food-insecure conditions - Contains a wide range of climate-relevant information	- A joint partnership between USAID, NASA, and USGS

Institution	Mandate / mission / interest for CC	Other information
NIGER INSTITUTIONS		
National Environmental Council for Sustainable Development (CNEDD)	- Define a national framework containing : policy, directions, objectives, strategies and programs of action with respect to environment and sustainable development - Develop, coordinate implementation, monitoring and evaluation of the National Environmental Program for Sustainable Development (PNEDD) - Framework of Action for action plans related to the three main post Rio '92 conventions - Initiate National Communications within the framework of Conference of Parties to the UNFCCC	- Head Office in Niamey - Placed under the control of the Primature - Devolved structures are provided for but they are not really functional - Members composed 1/3 of government services and structures, and for 2/3 of CSO - The position and the role of international NGOs are not clarified in the current texts
National Weather Management Authority (NWMA)	- Coordinate and harmonize the national weather policy - Conduct an observation of atmospheric behavioral patterns - Carry out forecasts for weather changes - Manage and operate observation networks and meteorological telecommunications - Distribute periodically information (weather bulletins, agro-hydro-meteorological ten-day, annual bulletins, etc.)	- Head Office in Niamey - Placed under the control of the Ministry of Transport
National Environmental Management Authority (NEMA)	- Develop, coordinate implementation of national policies, strategies, plans, programs and projects concerning : ✓ Fight against desertification (reforestation and land restorations, regional management, etc.) ✓ Environmental conservation and improvement of the living environment (forest planning, consciousness and supervision of forest resources, etc.) - Produce data, develop and monitor environmental indicators - Write the national report on the status of the environment	- Head Office in Niamey - Technical Department Ministry of Water, Environment and fight against Desertification
Early Warning System (EWS)	- Put in place a monitoring and information device on vulnerability indicators at the national level, so as to detect pre-incident indicators for a major food security crisis	- Head Office in Niamey - Placed under the control of the Primature - Information published to be tapped by

Institution	Mandate / mission / interest for CC	Other information
	- Conduct period publications in collaboration with several regional (AGRHYMET) and international (WFP, FEWS-NET) institutions on the updated situation for key indicators determining food security	another mechanism, the National System for Prevention and Management of Food Crisis[6] (NSPMFC) , also linked to the Primature, which plans, finances and monitors the main operations for alleviation of food crisis and global response to emergency situation crisis
Abdou Moumouni University (AMU)	- Train senior technical teaching staff and researchers - Train and retrain senior staff for different type of scientific and technical activities - Promote fundamental and applied research activities - Several AMU institutions[7] form the most senior staff and are engaged in research activities in fields related to inventory of greenhouse gas effect, alleviation and adaptation to side effects of CC in their respective sectors	- Head Office in Niamey - AMU falls under the Ministry of Secondary and Higher Education, Research and Technology (M SHE/RT)
National Institute for Agronomical Research in Niger (INRAN)	- Create and implement agronomical research programs in all sectors of rural development - Coordinate and supervise agronomical research in Niger - Contribute to the development of the national policy in the field of agronomical research - Contribute to the development of scientific and technical information and to the dissemination of the results and products of the research	- Public Administrative Institution (PAI), created by Ordinance N°75-01 of 7th January 1975 - Placed under the control of the Ministry of Agricultural Development
National Coordinating Committee of NGOs on Desertification (CNCOD)	- Coordination of different actions led by NGOs in the fight against desertification and in environmental conservation - Enhance the capacities of members with a view to have synergy in operations and efficiency in the actions - Contribute to the decentralization process within the framework achieving	- Head Office in Niamey - Created in 1996 ; point focal for INND in Niger - Consultative Organ bringing together eleven groups and NGO networks

[6] NSPMFC is supported technically and financially by a common fund of donors which brings together the main active donors in the prevention and management of food crisis

[7] Faculty of Sciences (Department of Physics, Department of Geology, Department of Chemistry); Faculty of Agronomy and the Regional Center for Specialized Teaching in Agriculture (RCSTA)

Institution	Mandate / mission / interest for CC	Other information
	synergy for the three United Nations conventions	working in the fight against desertification and environmental conservation : (+227) 90-14-43 - Email : CNCODniger@yahoo.fr
Network on Environmental for Sustainable Development (REDD)	- Encourage synergy between different operators so that the fight against environmental degradation in Niger has a united front - Encourage access to information, knowledge and financial sources for the benefit of its members - Contribute to the realization of PNEDD, SDR and the SDRP - Encourage common decision making on national and international stakes in respect to environmental strategy - Create a lobbying force and advocacy in the government and among development partners	- Head Office based in Niamey - Created on 18th July 2002 - Composed of 57 NGO and AD - Structured in 7 sectors of operation : FAD-NRM ; Water and Sustainable Development ; Energy and Sustainable Development ; Urban Environment and Local Environment ; Management of Biological Diversity ; Climate Change and Variation ; Environmental Education
Niger Youth Initiative for Climate Change (NYICC)	- Protect the environment - Promote planting of trees - Fight against effects of climate change - Participate in national debates and actions in relation to climate change	- Head Office based in Niamey - Created on 2nd June 2010 - Network composed of about ten youth organizations - National structure of a larger group in West Africa (Head Office based in Dakar) ; at African level (head office in Nairobi), and at international level (head office based in Denmark)
Action for Integrated Management of Resources (AGIR)	- Encourage private initiatives and promote AGR among rural, urban and peri-urban communities - Contribute to the conservation ecosystems in areas threatened with desertification - Contribute to search for solutions for conflicts between farmers and livestock keepers	- Head Office in Niamey - Operational branch in Dakoro - Contact : (+227) 96-88-91-02 / 90-29-75-85 - Email : b.soumana@yahoo.fr

Institution	Mandate / mission / interest for CC	Other information
	- Improve school enrollment rate for children in rural areas especially girls - Sensitize the communities on democracy and human rights	
BURKINA FASO INSTITUTIONS		
Ministry on the Environment and Sustainable Development (MESD)		
Ministry of Agriculture and Hydraulics		

National Council for the Environment and Sustainable Development (CONEDD)	- Located in the Ministry of the Environment and Quality of Life
	- The only office identified as having capacity on climate change; the issue is often confused elsewhere with general environmental management
	- UNFCCC focal point
	- Contains the following divisions
	  ○ Division des Politiques Environnementales (DPE)
	  ○ Division du Développement des Compétences, de l'Information et du Monitoring en Environnement (DCIME)
	  ○ Division du Partenariat et de ta Coordination des Conventions Internationales en matière d'Environnement (DPCIE)
		- No links have so far been made between disaster risk reduction and climate adaptation between CONEDD and the National Council for Emergency Relief and Rehabilitation

National Meteorological Service	- Provides weather and climate information for Burkina Faso. E.g., - 10-day agrometeorological bulletins (which contain written summaries on the general meteorological situation, rainfall, agrometeorology (humidity, evapotranspiration, solar radiation) and agricultural (phenology)) - Graphs and tables of station data and parameters on rainfall, evaporation, evapotranspiration, temperatures, soil temperatures, wind, humidity, and solar radiation - Seasonal climate forecast for the country.	
Direction of Production and Rural Economy (DGPER)		

Institution	Mandate / mission / interest for CC	Other information
Direction of Water and Natural Resources (DGRE)		
National Council for Emergency Relief and Rehabilitation (CONASUR)		
National Council on Emergency and Rehabilitation (CONESUR)		

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